EXPLORING COPPER CONTENT IN THE ENVIRONMENT OF KUNDILA, NIGERIA

Ahed J AlKhatib
Jordan University of Science and technology, Jordan
Murtala Muhammad
A. J. Alhassan
Ishaq.Y.Habib
Sani Y. Bala
Bayero University Kano, Nigeria
Auwal Adamu
Ahmadu Bello University Zaria, Nigeria

Abstract

Copper is an important element in small quantities, and it is associated with adverse effects when its concentrations exceed normal limits. Its exploring in environment gives an idea about its disposition. The purpose of the present study was to explore the environment load of copper in soil, water, and vegetables at Kundila, Nigeria. To achieve study objective, water samples, soil samples, vegetable samples of lettuce, spinach, and onions were randomly taken. All samples were processed and prepared for assaying copper using atomic absorption spectrophotometer. Study findings indicated that copper concentrations in soil and water were within reference range, but the three vegetables under study had high concentration of copper.

Keywords: Kundila, Nigeria, heavy metals, copper, environment

Introduction

Copper is considered as one of the world's most widely used metals (Anon, 1996), and is regarded as a potential hazard (Anon, 2003). Other researchers indicated that copper is also an essential micronutrient required by all organisms (Avenant- Oldewage and Marx, 2000) and is rapidly accumulated by plants and animals (Anon, 1996). Copper is generally more soluble in acidic waters at pH values below 6.5. It is easily adsorbed and precipitated in sediments at alkaline pH. The copper concentrations in plants above 0.005–0.02 mg/g are regarded as poisonous (Jones and Belling, 1967).

There are numerous reports of acute gastrointestinal effects in humans after ingestion of large amounts of copper in drinking water or beverages. The most prevalent effects are nausea and vomiting, which typically occur shortly after ingestion and are not persistent (Gill and Bhagat, 1999).

With the exception of several defined syndromes-Wilson’s disease, Indian childhood cirrhosis, and idiopathic copper toxicosis-liver effects are rarely reported in humans, although this has not been extensively investigated. In a compilation of case reports of individuals intentionally ingesting copper sulfate, jaundice was reported in 11 of 53 individuals (Chuttani et al, 1965).

Centrilobular necrosis, biliary stasis, elevated serum bilirubin level and aspartate aminotransferase activity, and elevated bile salts in the urine were found in five of the individuals with jaundice (Akintonwa et al, 1989). Centrilobular congestion (Lamont and DuflS, 1988), and acute hepato biotoxicity (Ahasan et al, 1994) have also been reported in case reports of lethal ingestion of copper sulfate.

Although a number of studies have investigated the mechanisms of copper hepatotoxicity in rats, it is not known whether rats would be a good model for human liver toxicity unrelated to a genetic defect in copper metabolism. Lysosomes serve an important role in hepatic copper metabolism. Excess copper is sequestered within hepatoeyte lysosomes where it is complexed with metallothionein. However, this protective mechanism is saturable and liver lesions can develop above the saturation limit. In copper loaded rats, lysosomes become enlarged and more fragile with decreased membrane fluidity (Myers et al, 1993). The results of the Haywood et al (1985) study do not suggest that liver damage is due to rupturing of lysosomes because lysosomal instability precedes and is not synchronous with liver damage. It is speculated that saturation of the lysosomes results in an accumulation of copper in the nucleus and subsequent nuclear damage (Fuentealba and Haywood, 1988).

The mechanism by which copper accumulates in the nucleus and the mechanisms by which it provokes injury are not clear. It has been suggested that excess copper results in oxidative damage, including lipid peroxidation Increases in the level of thiobarbituric acid reactive substance (TBARS), a measure of lipid peroxidation, have been found in copper-loaded rats (Myers et al, 1993; Sokol et al, 1993). However, a study by Aburto et al (2001) did not find significant alterations in the levels of malaondialdehyde, a lipid peroxidation by product, prompting the study authors to postulate that lipid peroxidation does not play a major role in copper toxicity although it may occur as a terminal event as a consequence of cell injury.

The present study was conducted to evaluate the copper levels in the environment of Kundila, Kano state Nigeria. Soil, water, and three vegetables: lettuce, spinach, and onion.

Methodology

For the purposes of the present study, the following random samples were taken: 12 soil samples and 8 water samples, in addition to 9 vegetable samples among which are three lettuces (lectuca sativa), three spinach (spinacia oleracea.l.) and three onions (allium cepa).

The soil samples were air dried, mechanically ground and sieved to obtained <2mm fraction of soil. Soil samples were digested as described by Allen et al (1974) and used for the analysis of copper using atomic absorption spectrophotometer. Digestion steps were carried out according to Allen et al (1974). Two grams of soil samples were wet with one to two drops of water, the sample was digested slowly in a digestion block for one hour after addition $2cm^3$ of sulphuric acid and $4cm^3$ of nitric acid. The digestion was finally diluted and filtered in 50ml volumetric flask and make up to mark with distilled water. The solution was used for copper determination. Water samples were collected randomly in plastic containers and digested for elemental analysis using atomic absorption spectrometry.

To a 100cm3 of water sample, l0 $cm^3$of conc. HNO3 were added and boiled slowly on a hot plate to evaporates to about $50cm^3$, after cooling another $5cm^3$ of nitric acid was added and returned the beaker to the hot plate and covered with a glass. Continuing heating was supplied with further addition of nitric acid and completed the digestion when slight colored solution was observed. The beaker wall and watch glass was washed down with distilled water and filtered the solution in to 100ml volumetric flask and diluted to mark with distilled water. The filtrate was used for the analysis of copper.

Plant samples were put through a three washing sequence (Reuter et al, 1983), air dried, weighed and placed in a muffle furnace to form an ash which was used for acid digestion (Miller, 1998). Plant digest were used for copper analysis by atomic absorption spectrophotometer. Analysis of edible fauna and flora material practically requires ashing of the dry material. Atomic absorption spectrophotometer offers the advantage that, the ash mostly dissolved in dilute hydrochloric acid can be analyzed directly (Bernard, 1985). Ashing with addition of nitric acid gives very satisfactory results and was adopted (AOAC 1990).

Statistical analysis

Data were analyzed using SPSS version 20. Data were presented as means and standard deviations.

Results

As shown in table 1, the mean concentration of copper in soil samples at Kundila is 7.34±2.302 µg/g, and the range for copper concentration at Kundila is 5.041-9.64 µg/g. The mean concentration of copper at Kundila for water is 0.75±0.18 mg/l. The mean concentration for water was within the range of 0.57-0.93 mg/l.

Table 1: Copper concentration in soil and water at Kundila (Nigeria)

	Soil (µg/g)	**Water (mg/l)**
Copper (Mean ±SD)	7.34±2.302	0.75±0.18
Range	5.041-9.64	0.57-0.93

As shown in table 2, the highest concentration of copper is seen for spinach 56.99± 13.71 mg/kg followed lettuce 44.91± 7.91 mg/kg. The lowest concentration of copper is seen for onion 15.54± 5.18 mg/kg.

Table 2: Copper concentration in some vegetables of Kundila (Nigeria)

	Lettuce (mg/kg)	**Spinach (mg/kg)**	**Onion (mg/kg)**
Copper (Mean ±SD)	44.91±7.91	56.99±13.71	15.54±5.18
Range	36.99-52.82	43.29-70.70	10.36-20.73

Discussion

The present study purposes to assess the environmental exposure to copper in various environmental aspects including soil, water, and vegetables at Kundila, Nigeria. Copper concentration in soil was 7.34±2.302 µg/g.

Compared with studies in literature, the results of the present study are less than reported otherwise (NEPMU, 1999) in which the limit is l00ug/g and UNESCO/WHO/UNEP (1992) limits (37.5 ug/g). Other studies including Anthony and Balwart (2006) who reported soil with copper concentration of 338 ug/g at port kembla and that obtained by Beavington (1973); 343 ug/g.

The data of the present study demonstrated that the mean concentration of copper in water was 0.75±0.18 mg/l, and his concentration is below the limits of WHO(1993) limit (2.0mg/l) and USEPA (1996) limit (1.3mg/l).

The mean concentration of copper in lettuce was 44.91±7.91 mg/kg. this concentration is considered high compared with other data. Copper limits were shown to be 5 mg/kg FAO/WHO (1993). limits (5.0mg/kg) and WHO/EU (1993) limits (0.2mg/kg). Copper concentration in our study is also higher than that reported by Beavington (1996) in which copper concentration was 23mg/kg in lettuce at port kembla, and also higher than that of Anthony and Balwart (2006) who reported a mean copper concentration 27.6mg/kg.

The data of our study showed that he mean concentration of copper in Spinach was 56.99±13.71 mg/kg. The concentration of copper in spinach from Kundila is considered higher than values reported by FAO/WHO (1993) I which the copper concentration was limited up to 5 mg/kg, and WHO/EU (1993), in which limits of copper is up to 0.2mg/kg. our data for copper concentration in spinach is also higher than that reported by Vausta et al (1996) who found copper concentration at Greece ranged from 17.9mg/kg to 39.5mg/kg).

Copper concentrations in onion bulbs was 15.54±5.18 mg/kg. Onion's content of copper is higher than that reported by FAO/WHO (1993) in which copper limits were up to 5.0mg/kg, and it was also higher than the limits of MAFF (1992) limit 5.0mg/kg and limits of WHO/EU (1993) 0.2mg/kg.

Copper concentration in onion in our study is higher than that reported by Audu and Lawal (2005), who found the copper concentration in onion up to 7.5mg/kg.

Conclusion

The present study explored the disposition of copper in the environment of Kundila, Nigeria. We tracked the copper in soil, water, and vegetables in the study area. Although the study findings did not point to contamination of soil and water at Kundila by copper, the concentration of copper in lettuce, spinach, and onion was high compared with literature.

References:

Aburto, Crib AE, Fuentealb I,AC murphy (2001). Morphological and biochemical assessment of liver response to excess dietary copper in Fischer 344 rats. Can Jvet Res 65(2): 104-1101.

Ahasan, H.AMN, Chowd Hury. MAJ, Azhar, MA (1994). Copper Sulphate poisoning Trop Doct 24(2): 52-53.

Akintonwa. A, Mabudeje AFB, Odutola TA (1989). Fatal poisonings by copper sulphate ingested from “spiritual water” Vet itum toxico 31(5). 453-454.

Anon (1996). South African water quality guidelines. 2nd Edition, Domestic Use 1, Department of Water Affairs and Forestry, South African.

Anon (2003). Monitoring and assessing of water quality. U. S. Environmental Protection Agency, viewed at http://www.epa.gov/owow/monitoring/volunteer/stream on 29/04/2005.

Anthony K, Balwart S (2006). Heavy metals contamination of home grown vegetables near metal smelters in N.S.W Sydney. Super soil, faculty of agriculture food and natural resources ,university of sydney Australia. Retrieved june 2008, from http://www.Regional.org.au/au/asssi/super.

AOAC (1990). Journal of the association of official analytical chemist 68,499. Ashworth and Alloway B.J, the mobilization of trace elements in contaminated soils, prost, Red, 3”’ international conference on the biogeochemistry of trace elements, 15-19 may 1995.
Audu AA, Lawal A.O (2005). Variation in metal contents of plants in Vegetable gardens sites in Kano metropolis J. Appi .Sci. Environ manage. 10(2): 105-109.
Avenant–Oldewage A, Marx HM (2000) Bioaccumulation of chromium, copper and iron in the organs and tissues of Claria gariepinus in the Olifants River, Kruger National Park. Water SA 26: 569–582.
Beavington F (1973), contamination of soil with zinc, copper, lead and Cadmium in the wollongon city area Australian journal of soil research. 11,27-31.
Bernard D,W (1985) Atomic absorption spectrometry. 2nd edition (English translation by christophers.) VSH publisher. USA. PP 361-366.
Chuttani HK, Gupta Ps, Gulati 5, et al (1965). Acute copper sulfate Poisoning. Am j med 39: 849-854.
FAO/WHO (1993), Food additives and contaminants joints, FAO/WHO Food standard program 2001 ALINORM 01/12A, 1-289.
Fuentealba, Haywoods (l988). Cellular mechanisms of toxicity and tolerance in copper loaded rat I. ultra structural change in the liver, 8:272-380.
Gill jS, Bhagat CI (1999) Acute copper poisoning from drinking lime cordial preparation and left overnight in an old urn Med J Aug 170(l0):510.
Haywoods, Loughran M, Ban RM john, white (1985). Copper toxicosis and tolerance in Rat. Ill Intracellular localization of copper in the liver and kidney exp mol pathol, 43:209-2 19.
Jones GB, Belling GB (1967) The movement of copper, molybdenum and selenium in soils as indicated by Radioactive Isotopes. Australian Journal of Agricultural Research 18: 733–740 .
Lamont DL, Duflon SALC (l988). Copper sulfate. Not harmless chemical. AM J forensic Med pathol 9(3):226-227.
MAFF, Welch office Agricultural depertinent (1992). Code of good agricultural practice for the protection of soil, Draft consultation. Document, MAFF London.
Miller-Ihli, NJ (1998). Atomic absorption and atomic absorption and Atomic emission spectrometry for the determination of trace elements contents of selected fruits consumed in the united states. J Food Composs Ana 1.9:301-311.
Myers BM, Predergast FG, Holman R. G.B, (1993). Alterations in hepatocyte lysosomes in experimental and pesticides in man Arch environ Health 41(1): 49-55.

NEPMU (1999) National environmental protection, assessment of site contamination measures. National environmental protection council Adelaid Http://www/ephc.gov.au/nepms/cs/consite.html.

Reuter, D,J, Robinson YB, peverrill Kj (1983). Guidelines for collecting, handling and analyzing plant material. In plant analysis an interpretation manuals. Eds DJ Reuter, J B robinson PP. 20-30 Inkarta Press: Melborne.

Sokol R.j, Deveraux MW, Obrienk, et al (1993). Abnormal hepatic mitochondrial respiration and cytoehrome C activity in rats with long term copper overload. Gastroenterology 105(1): 178-187.

UNESCO/WHO/UNEP (1992). Water quality assessment. Chapman and hall Ltd, London, PP 10-13.

USEPA (1996) Acid digestion of sediment, sludge and soils: method 3 OSB(USEPA: Washington).

Vausta, D Grimunis, A, Samarac (1996) trace elements in the vegetab1es grown in an industrial area in relation to soil and air particulate matter Environmental pollution 94,325-335.

WHO (1993): World health organization Guidline for Health Metals standerds in drinking water, retrieved on 24th aug 2008. from http://s.it techonline.com (book) envron-tech/ISBN 987-3-902613-10-3 env 03.pdf.

WHO/EU (1993): WHO and EU guidelines for heavy metals and thresh hold values leading contamination of crop plants. 1993.